PROPULSION DIRECTORATE

Monthly Accomplishment Report
June 2005

Contents ***Page***

SECOND FALCON HYBRID MOTOR FIRING SUCCESSFUL: On 10 June 2005, Lockheed Martin successfully test-fired a hybrid motor at AFRL facilities as part of the Falcon Small Launch Vehicle (SLV) Program. This was the second SLV hybrid motor firing conducted this year at the Propulsion Directorate's Test Stand 2-A at Edwards AFB, California. The hybrid motor that was tested is a full-scale test version of the upper stage motor on Lockheed Martin's SLV and measures 11 feet in length and 5 feet in diameter. The motor fired for the planned duration of 120 seconds, twice the length of time of the first firing that occurred 21 January 2005. It is believed that the 120-second test was the longest burn of a hybrid motor of this scale. Preliminary data indicate that the test objectives were met, and this firing serves as a significant accomplishment toward reducing the program's technical risk. The goal of the Falcon SLV Program is to develop and demonstrate an affordable and responsive space lift capability that can quickly launch a small satellite into Low Earth Orbit. Hybrid motors combine the best of solid and liquid propulsion systems, typically using an inert fuel and liquid oxygen to generate thrust. Hybrid propulsion offers significant gains in safety, throttle-ability, cost, and affect on the environment. The Defense Advanced Research Projects Agency (DARPA) and the US Air Force are leading the SLV Program. (Mr. E. Spero, AFRL/PRSE, (661) 275-5972)

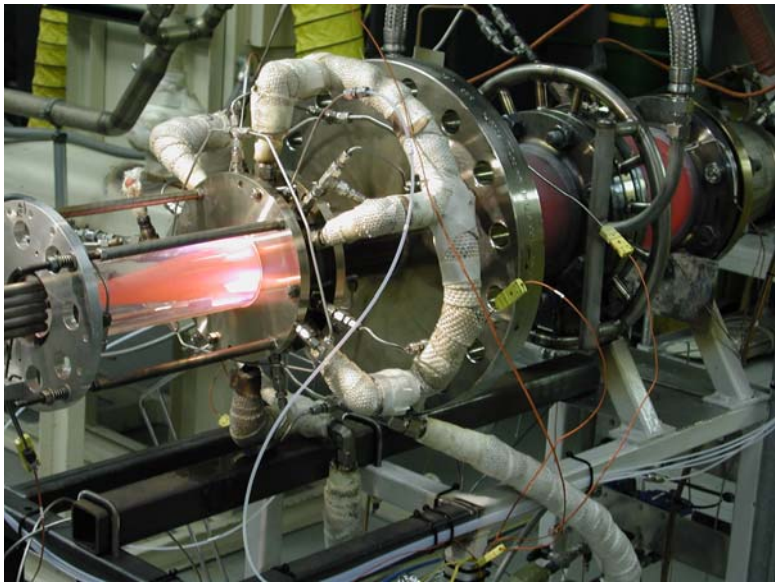
Want more information?

- An AFRL release on this test is available here.
- A Lockheed-Martin release on this test is available here.

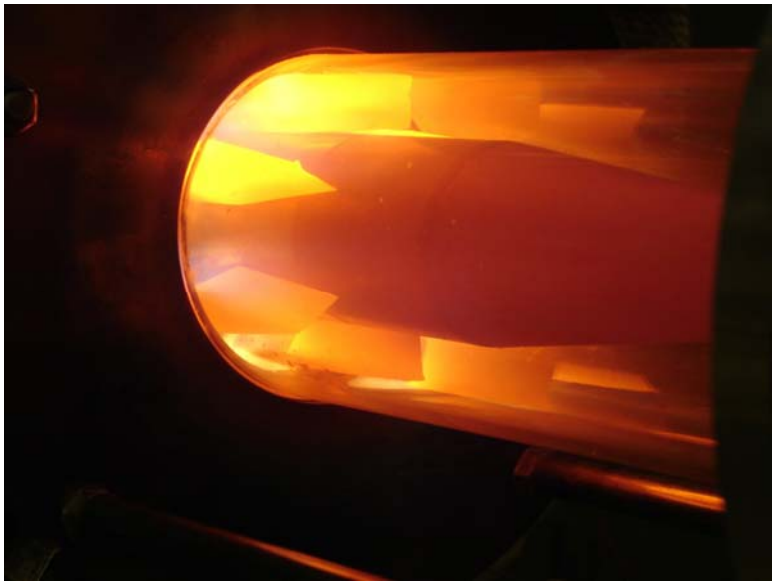
A hybrid motor is fired at Test Stand 2-A at Edwards AFB

INTER-TURBINE BURNER EXPERIMENTS DEMONSTRATE CONCEPT FEASIBILITY: The Propulsion Directorate's in-house Ultra-Compact Combustor (UCC) Team successfully operated the AFRL-developed UCC in Inter-Turbine Burner (ITB) mode through the use of a

secondary combustion system upstream to simulate the actual engine environment. UCC technology is essential to the development of near-constant-temperature-cycle turbine engines. This technology can provide a significant reduction in engine weight and size while providing large amounts of power. A simple swirl-stabilized combustion system provided ITB inlet air at different vitiation levels (i.e., oxygen levels) to simulate the hot, reacted mixture that would exit the high-pressure turbine (HPT) in a gas turbine engine. Four different ITB design configurations were tested, based on the AFRL-conceived high-g compact combustor concept. Lean blowout fuel-air ratio limits at 25-50% the value of current systems were demonstrated. These results are significant because the ITB only requires a small (300°F) temperature rise for optimal power extraction, leading to operation of the ITB at near-lean-blowout limits of conventional combustor designs. The combustor was able to operate at required fuel-air ratios with significant margin. In addition to lean blowout measurements, combustion efficiency was measured over a wide range of vitiator and ITB operating conditions. This data begins to build the design space required for future engine designs that may use ITB systems. (Dr. J. Zelina, AFRL/PRTC, (937) 255-7487 and Capt R. Greenwood, AFRL/PRTC, (937) 255-7098)



Experimental setup showing the vitiator (far right) and the Inter-Turbine Burner (ITB) on the left



Close-up of ITB showing the vanes and center-body hardware

ROCKET ENGINE TESTING REACHES ANOTHER MILESTONE: AFRL's Propulsion Directorate achieved a significant milestone for rocket propulsion during testing of the Integrated Powerhead Demonstration (IPD) ground demonstration engine at NASA Stennis Space Center (SSC), Mississippi on 28 June 2005. During this test, combustion in both the hydrogen and oxygen preburners and in the main combustion chamber was successfully sustained. It is the first known demonstration of full flow staged combustion. The test ran for 5.85 seconds and no

anomalies were noted and all objectives were achieved. The project is now positioned to develop and test fire the first new liquid engine cycle developed in the last 35 years, dating back to the development of the Space Shuttle's Staged Combustion Main Engine. The IPD Program addresses the DoD/NASA Vision and commercial needs as a technology research and development program aimed at dramatically increasing safety and reliability while reducing the cost of a rocket engine system for a reusable launch vehicle. Through the utilization of the Full Flow Staged Combustion Cycle (FFSC), the IPD engine can achieve life and reliability 10 times greater than the Space Shuttle Main Engine. The IPD Program will ultimately satisfy the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) Phase 1 Cryo Boost goals in addition to NASA's Exploration Systems Mission Directorate goals. (Mr. S. Hanna, AFRL/PRSE, (661) 275-6021)

Integrated Powerhead Demonstration (IPD) testing is performed at NASA Stennis Space Center

COL HEIL RETIRES; DR. BORGER TAKES THE HELM IN PR: In a ceremony held on 10 June 2005 at the Air Force Institute of Technology (AFIT), Colonel Michael Heil retired from the US Air Force and stepped down as the Director of AFRL's Propulsion Directorate. During his distinguished 30-year career, Col Heil held several high level positions, including Commander of Phillips Laboratory, Commander of the Arnold Engineering Development Center, and Commandant of AFIT. With AFRL Commander Major General Perry Lamy presiding, Dr. William U. Borger assumed the role of AFRL/PR Director. In this role, Dr. Borger will be responsible for directing the Air Force's science and technology program in propulsion and power for space, missile, and aircraft applications. AFRL/PR has more than $3 billion in

research facilities at Wright-Patterson AFB, Ohio, and Edwards AFB, California, a work force of more than 1,000, and an annual budget of $250 million. Dr. Borger comes to AFRL/PR from an assignment as Director of Plans and Programs for AFRL. (Mr. J. Pearce, AFRL/PRO (UTC), (937) 255-5015)


Col Michael Heil


Dr. William U. Borger

IHPTET DEMO ENGINE TO TEST CERAMIC MATRIX COMPOSITE TURBINE BLADES: The joint AFRL, Navy, General Electric Aircraft Engines, and Allison Advanced Development Company team will be testing Ceramic Matrix Composite (CMC) blades in the low-pressure turbine (LPT) of the XTE76/1 demonstrator engine. Leveraging past AFRL experience and the Integrated High Performance Turbine Engine Technology (IHPTET) Program, the team has produced a full set of high quality blades and


A ceramic matrix composite turbine blade

has assembled them into the engine for testing at the end of 2005. The uncooled CMC blade will offer a significant temperature increase to similar cooled metal LPT blades. This will allow for a significant reduction in the cooling air required by conventional metal blades which translates into increased system thrust. In addition, CMC density is one-third of traditional airfoil materials and its coefficient of thermal expansion is a quarter of traditional nickel-based alloys. The combination of the lower weight airfoil and lower thermal expansion will yield better turbine clearances and lower maneuver deflections in the LP system while meeting full life requirements. Testing of this uncooled blade is the first step in the plan to design a cooled CMC LPT blade for future F136 growth and long range strike propulsion systems under the Versatile Affordable Advanced Turbine Engines (VAATE) Program. Once demonstrated, several LPT parts could be manufactured with CMC materials resulting in even greater payoffs. (Mr. A Cerminaro, AFRL/PRTP, (937) 255-7622)

MS. HARTSOCK RECOGNIZED FOR IMPROVING BUSINESS PRACTICES: The Propulsion Directorate's Ms. Linda R. Hartsock recently received the Exemplary Civilian Service Award. Ms Hartsock was recognized for her outstanding performance as a Management Analyst in AFRL/PR's Business Services Branch (AFRL/PROB) from December 2002 to February 2005. During this time, she provided key support to several areas, such as the Congressional Descriptive Summaries (RDT&E Budget Justifications), Defense Technical Information Center (DTIC) processes, AFMC Scientific and Technical Information Office (STINFO) processes, and the AFMC's Scientific and Technical Information Enterprise Solution (STES). Her efforts have paid dividends in many areas. She designed, developed, and implemented processes for tracking technical reports using STINFO. Her processes were adopted as a "Best Practice" in AFRL, and delinquent technical reports were reduced by 60%. Furthermore, her work to resolve problems with research effort summary submissions and delinquent reports has reduced delinquencies from 22% to 5% annually. She has also been a leader in transforming processes related to Laboratory Management Reviews (LMRs). Ms. Hartsock authored an internal tracking, reporting, and administrative process in conjunction with the annual data calls in support of DTIC, and her process was so successful that all of the LMRs required were accomplished prior to the deadline. (Ms. S. Steltz, AFRL/PROB, (937) 255-1889)


Ms. Linda Hartsock